

Portable Data Acquisition and Quench Protection System for use with the MICE Spectrometer Solenoid Test

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Darryl Orris

Instrumentation & Controls Group Leader
Fermilab/TD/Test and Instrumentation Department

Portable DAQ & Quench Protection System

- A portable DAQ/Quench Protection System has been built and is ready to be shipped to LBNL
- This work was performed in response to a request to adapt a Fermilab mobile DAQ and Active Quench Protection System for testing the MICE Spectrometer Solenoid

Portable DAQ & QP Requirements

- The following is the scope of capabilities requested for use with the MICE Spectrometer Solenoid Tests:
 - The HTS Lead voltages will be monitored for a quench and a quench trigger will be sent to the power system if the voltage threshold is exceeded
 - The LTS Lead voltages will be monitored for a quench and a quench trigger will be sent to the power system if the voltage threshold is exceeded
 - The diode voltages will be monitored and the data logged; however, no action will be taken to send a quench trigger to the power system
 - The Power Supply Current will be monitored and logged
 - A trigger from the power system will be used to capture a window of data with the mobile DAQ/QP system if the MICE system detects a coil quench

Recently Suggested Additional Capabilities for QP

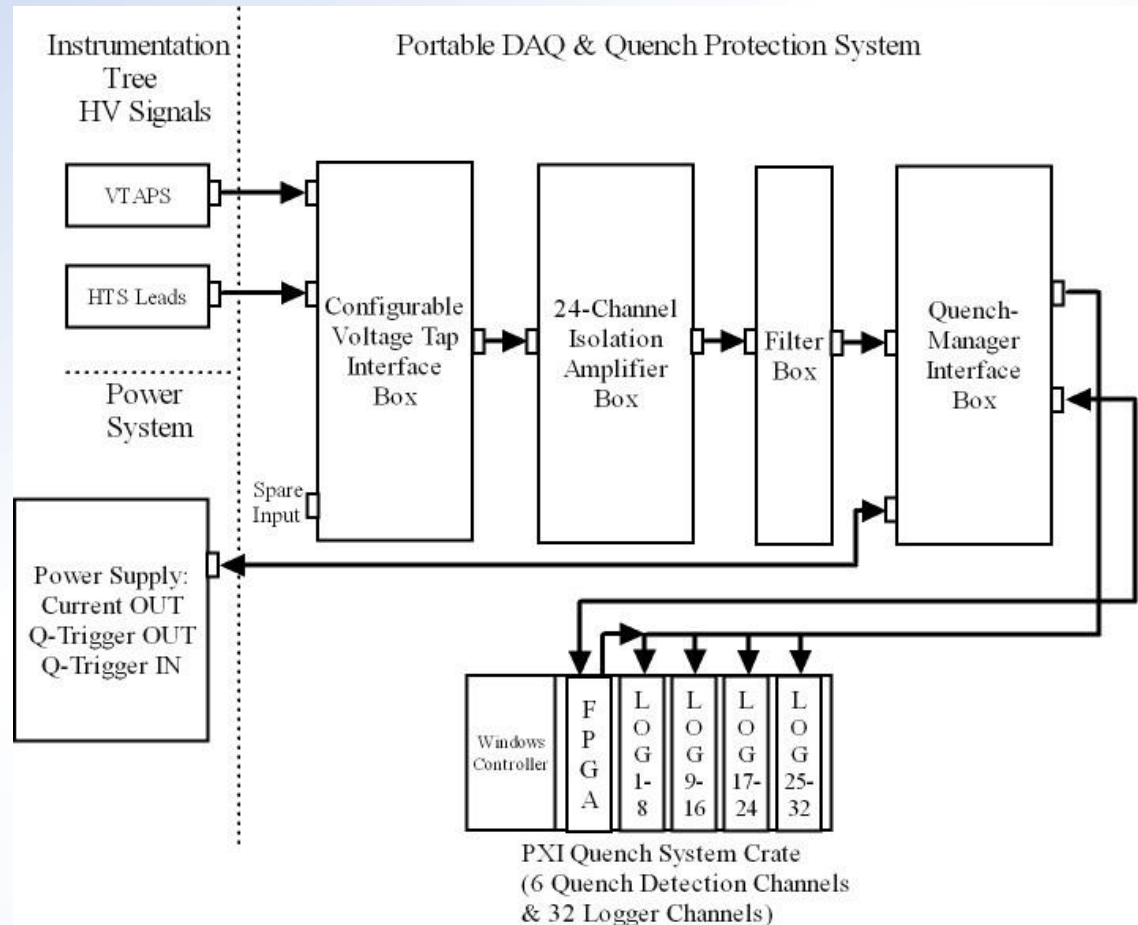
- It was suggested in December that it may be prudent to include the capability to act (generate a quench trigger) on diode voltages exceeding a threshold value
 - The system will have this capability but it will be disabled until the diode voltage signals have been analyzed
 - We need to determine if it is possible to use active quench protection from the diode voltages without causing unwanted trips due to noise

Portable DAQ & Quench Protection System Block Diagram

Signals from the HTS leads, SC Leads, diodes, and the PS current are picked up at the instrumentation tree and the power supply.

The solenoid voltage signals are amplified, filtered, summed, and then distributed to the FPGA module for quench detection and to the data loggers for monitoring and data logging.

A quench trigger from the FPGA is sent to the power supply shut-off and visa-versa.



Portable DAQ & Quench Protection Custom Built Components



← 24-Channel
Configurable
Voltage Tap (CVT)
Box

24-Channel, SPI Bus
Programmable Isolation
Amplifier Box
(NI USB 8451 Interface) →



← Filter Box –
DIP-Switch Settable
Single-Pole Filters:
 $10\text{Hz} < f_c < 1\text{kHz}$

Quench Manager
Interface Box →



Portable DAQ & Quench Protection Commercial Components



NI PXI-8109 – 2.66GHz
Dual-Core PXI Embedded
Controller, 320GB HD,
8GB RAM, Windows-7
64-Bit OS



NI PXI-7833R -- R Series
Multifunction RIO with
Virtex-II 3M Gate FPGA



NI PXI-6143 -- 16-Bit, 250
kS/s/ch, Simultaneous
Sampling Multifunction
DAQ

Portable DAQ & Quench Protection Final Product



24-Channel CVT Box

24-Channel Programmable
Isolation Amplifier Box

DIP Settable Filter Box

Monitor, Keyboard, & Mouse

Quench Manager Interface Box

PXI Crate with Embedded Controller, FPGA
Module, & 4 8-Channel Simultaneous Sampling
Data Loggers

Misc. Parts/Tools Drawer

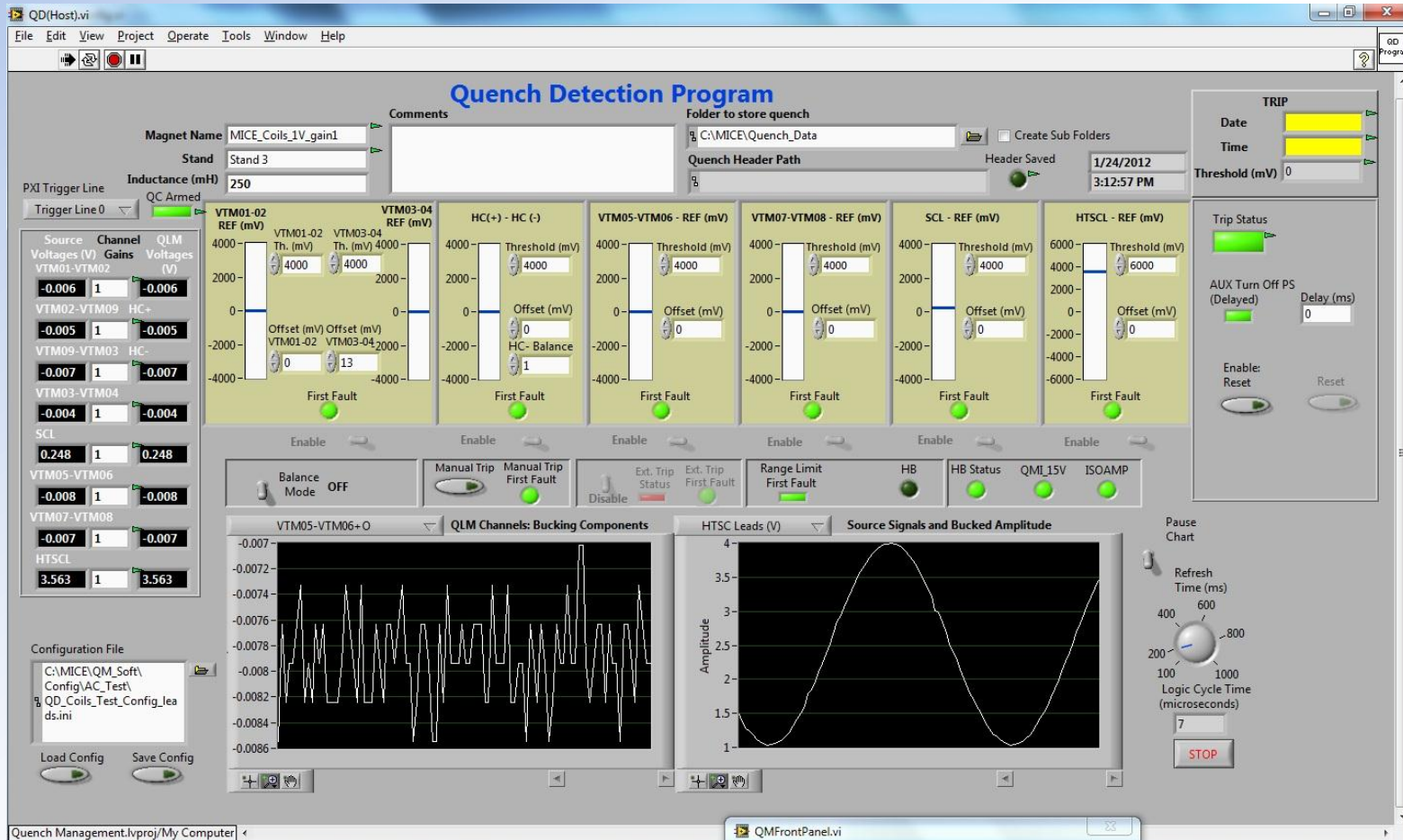
System Capabilities

- The active quench detection system is based on National Instruments FPGA, which has six channels of digital quench detection (DQD). Each DQD channel bucks signals, compares threshold voltages, and sends a quench trigger when a threshold is exceeded
- The data loggers can continuously log the data from all 32 channels simultaneously at rates between 0.1Hz and 100Hz (Slow Logger mode) while remaining armed to capture a user specified window of data at up to 10kHz (Fast Logger mode) in response to a quench trigger
- Decimated data is also displayed in real time on the front panel
- A Data Analysis tool is provided, which has provisions to save the data in ASCII format for use with user preferred analysis tools
- An operator's manual will be provided

Performance Expectations

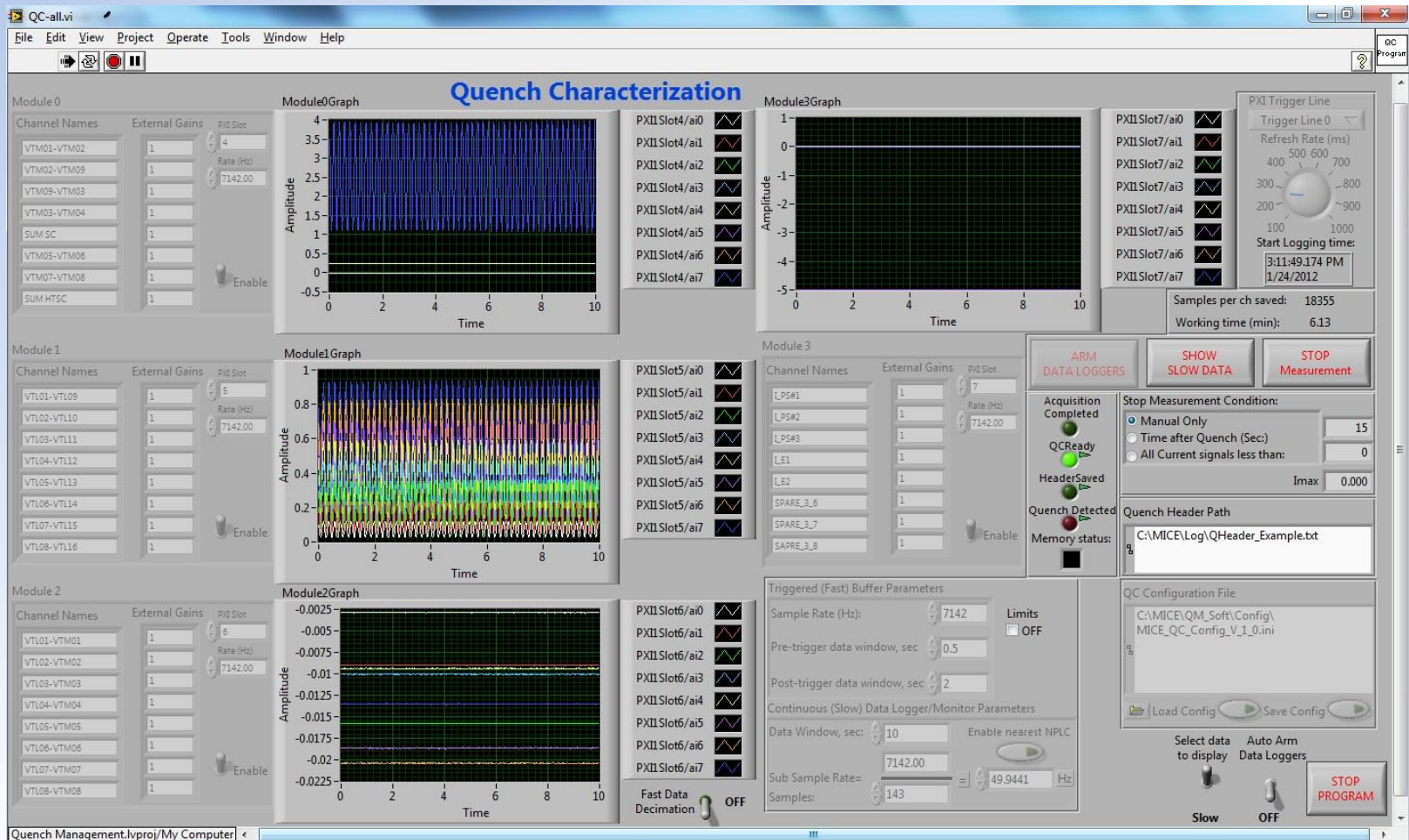
- After assembling this system, all channels were characterized for noise and cross-talk using a 90mH inductive load at up to 50A and the noise level was $<1\text{mV}_{\text{p-p}}$ at current
- When using this system to test the MICE Spectrometer Solenoid , the noise levels will depend on how the voltage tap wires are routed, twisted, and shielded inside the cryostat as we proposed for noise mitigation
- The DAQ/QP system is capable of filtering the signals but the minimum obtainable threshold levels will ultimately depend on the internal wiring of the cryostat and the power system noise

Quench Detection Front Panel



6 DQD Channels with Balancing, Bucking, and Threshold Controls as well as signal monitoring

Quench Characterization Data Logger Interface



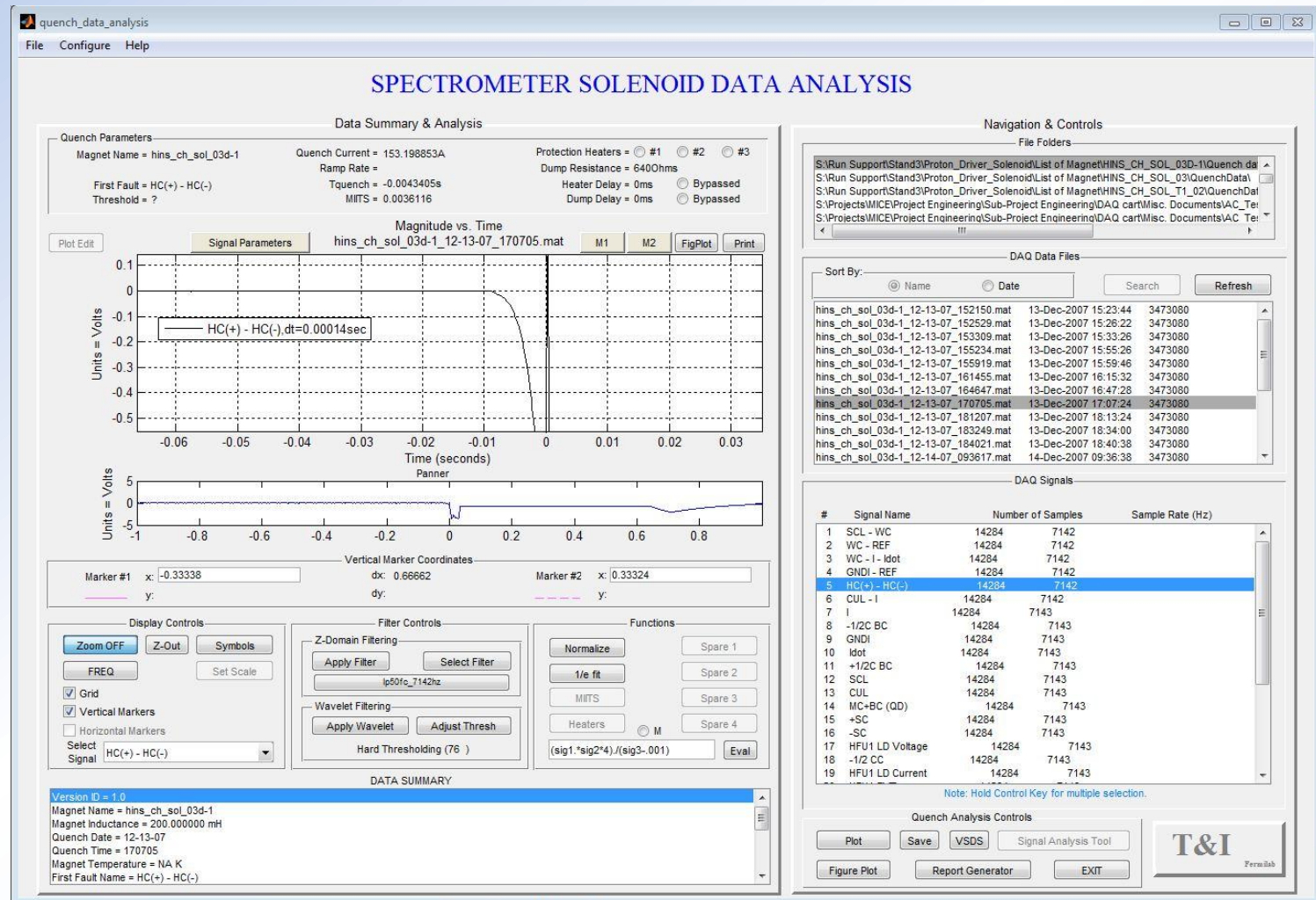
Front Panel – Slow Logger Data Monitoring and Configuration Controls

Data Analysis Tool

Quench Data Analysis – Main Panel

Provides FFTs, FIR & IIR Filtering, Wavelet Filtering, etc.

Accepts Matlab commands, and saves data to ASCII format for use with other analysis tools



Concerns

- Is clean power available for the DAQ / Quench Protection System?
 - This system requires a 120V/20A power connection
- Who at LBNL will be taking over the operation of this system?
 - Two of us from Fermilab will come for the 1st week of testing at Wang NMR to setup the DAQ/QP system and to train someone at LBNL – we would like to start interfacing with this person as soon as possible

Conclusions

- A portable DAQ/Quench Protection System has been built and is ready to be shipped to LBNL
- All hardware and software has been fully tested and is ready for deployment
- The data will be saved to disk and can be accessed and analyzed offline
- Two of us from Fermilab will be available the 1st week of testing to setup the system and train someone from LBNL to operate it